MODELING OLFACTORY BULB: ODOR CODING AND PROCESSING OF ODOR MOLECULE INFORMATION

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Abstract: The sense of smell is an important sense to both humans and animals. The olfactory bulb aids in discriminating and identifying different odors. It receives all the chemical sensory information from the olfactory epithelium, processes the information in the intermediate layers, and projects the transformation onto the olfactory cortex. The olfactory bulb receives input not only from the sensory neurons but also from the other parts of the brain through the centrifugal afferent pathways. These pathways initiate in the olfactory cortex, and the anterior commissure and terminate mostly on the granule cells.

To understand and simulate neuronal mechanisms as to how the olfactory cortex combines and distinguishes signals from large number of glomerular modules is challenging. Knowledge about the way in which the neurons encode the information would be very helpful to simulate the process of odor separation.

Our aim is to show the way in which the odor is represented, and how the receptors would react to samples of odor. The odor input varies with time according to the sniff cycle. The simulation of how the odor input varies with time is demonstrated. Only the excitatory mitral cells receive the sensory input through the axons, which connect the odor receptors and glomerular cells. These mitral cells then integrate and fire to produce a spike, which is then sent to the olfactory cortex. If the total excitation caused by the input is sufficient, the output signal is emitted and propagated along the axons and its branches to the other neurons.

A stimulus (odor input) evokes a spike train from a neuron; this spike train is the coded form of the stimulus. The time period of the spike train is dependent on the stimulus (odor input). The time course of the stimulus can be estimated from the spike train. Reconstruction of the stimulus can be done if the time period of the spikes is known. The tuning specification between the mitral and tufted cells and their glomeruli plays a vital role in mitral and tufted cell’s spike response to a particular odor. Our experiments indicate that a single mitral or a single tufted cell show excitatory spike response to a range of odor molecules with similar molecular configuration. The behavior of the receptor cells in response to the simulated odors shown is close to the actual biological behavior of the receptors present in the olfactory epithelium.

Keywords: olfactory modeling, spiking neurons, brain function analysis